SPECIFICATION

[Title of the Invention]

OPTICAL PICKUP AND OPTICAL RECORDING AND/OR REPRODUCING APPARATUS USING THE SAME

[Brief Description of the Drawings]

The above and/or other aspects and advantages of the invention will become apparent from the following description of the embodiments, taken in conjunction with the accompanying drawings in which:

FIG. 1 shows the adjustment of the convergence and/or divergence of light according to the distance between a radiant point of a light source and a collimating lens according to a prior art;

FIG. 2 schematically shows the main structure of an optical pickup according to a preferred first embodiment of the present invention;

FIG. 3 is a schematic plan view of a hologram pattern of a hologram optical element used as an optical element of FIG. 2;

FIG. 4 shows the optical structure of an optical pickup according to a preferred second embodiment of the present invention;

FIG. 5 shows the optical structure of an optical pickup according to a preferred third embodiment of the present invention;

FIG. 6 shows the optical structure of an optical pickup according to a preferred fourth embodiment of the present invention; and

FIGS. 7 through 9 show examples of a beam shaping device used in an optical pickup according to the present invention.

[Detailed Description of the Invention]

[Object of the Invention]

[Technical Field of the Invention and Related Art prior to the Invention]

The present invention relates to an optical pickup and an optical recording and/or reproducing apparatus using the same, and more particularly, to an optical pickup capable of adjusting the convergence and/or divergence of light and an optical recording and/or reproducing apparatus using the same.

Referring to FIG. 1, divergent light emitted from a light source 1, for example, a semiconductor laser, can be converted into parallel light by way of a collimating lens 3.

In order to make the divergent light emitted from the light source 1 into parallel light after passing through the collimating lens 3, the distance between a radiant point of the semiconductor laser 1 and the collimating lens 3 must be equal to the flange back length of the collimating lens 3. Here, since, in a case of using a thick lens, the focal length occupies up to a middle portion of the thick lens, it is difficult to define the focal length. Thus, the term "flange back length" is referred to as the general mechanical length. The flange back length of a collimating lens, as well known to those of ordinary skill in the optics field, is referred to as the back focal length of the collimating lens, in a case where optical components are not disposed between a radiant point of a light source and the collimating lens. However, the term flange back length may be used even in a case where optical components are disposed between a radiant point of a light source and the collimating lens.

As can be seen from FIG. 1, if the distance between the radiant point of the light source 1 and the collimating lens 3 is longer than the flange back length, the light passed through the collimating lens 3 becomes convergent light. On the contrary, if the distance between the radiant point of the light source 1 and the collimating lens 3 is shorter than the flange back length, the light passed through the collimating lens 3 becomes divergent light.

As described above, the distance between the radiant point of the light source 1 and the collimating lens 3 affects the convergence and/or divergence of light.

Since an optical pickup includes various optical components, when the optical components are aligned and assembled optically, the manufacturing tolerance of the

optical components themselves and the assembly tolerance between the optical components occur. Such tolerances are accumulated throughout the optical pickup and thus optical aberration is generated in the optical pickup due to accumulation of the tolerances.

An optical pickup including a collimating lens having a long focal length is assembled such that optical components are disposed at desirable positions on mechanical structure, and the optical components are fixed using adhesive means such as an adhesive. Since parallelism of light emitted from a light source falls within an allowable value within a marginal value of assembly tolerance in the optical pickup assembled as described above, the distance between the light source and the collimating lens does not need to be adjusted.

Meanwhile, an optical recording and/or reproducing apparatus for a notebook computer uses a slim optical pickup, and the slim optical pickup must include a collimating lens having a short focal length in order to satisfy the mechanical distance of the slim optical pickup.

Even if the distance between a light source and the collimating lens slightly deviates from the flange back length of the collimating lens in the optical pickup including the collimating lens having the short focal length, causing the parallelism of light emitted from the light source to be very poor, the assembly tolerance of the optical pickup must be managed strictly. Thus, the management of the convergence and/or divergence of light, that is, the management of parallel light, is necessary for the optical pickup including the collimating lens having a short focal length.

In a case where an optical pickup includes a beam shaping device which makes the shape of a light beam emitted from a light source, when convergent light or divergent light, not parallel light, passes through the beam shaping device, optical aberration of the optical pickup may be deteriorated considerably. Thus, the management of the convergence and/or divergence of light, that is, the management of parallel light is necessary for the optical pickup including the beam shaping device.

Considering this respect, in an optical pickup which is necessary for management of specific aberration characteristics, such as an optical system which greatly generates the optical aberration due to the convergence and/or divergence of light and includes the collimating lens having a short focal length or the beam shaping device, light passing through the collimating lens must be parallel light or close enough to parallel light that optical aberration falls within an allowable value within a marginal value of the assembly tolerance of the optical pickup.

The management of the parallel light is achieved by disposing optical components at desirable positions on a mechanical structure, for example, by changing the position of the collimating lens along an optical axis in a state where the light source is fixed at a desirable position and by adjusting the distance between a radiant point of the light source and the collimating lens.

However, adjusting the position of the collimating lens along the optical axis for the management of the parallel light makes a process for assembling the optical pickup complex, because adjusting of the position of the collimating lens along the optical axis is carried out in a state where the central axis of the collimating lens is parallel and identical to the optical axis. In reality, it is a difficult job to move the collimating lens in the state where the central axis of the collimating lens is parallel to the optical axis. Thus, the adjustment of the convergence and/or divergence of light due to adjustments in position of the collimating lens makes a process for assembling the optical pickup complex, resulting in an increase in the cost of manufacturing the optical pickup.

[Technical Goal of the Invention]

The present invention provides an optical pickup in which adjustment of the convergence and/or divergence of light is easily accomplished and an optical recording and/or reproducing apparatus using the same.

[Structure and Operation of the Invention]

According to an aspect of the present invention, there is provided an optical pickup which condenses light emitted from a light source using an objective lens and irradiates the light on an optical recording medium in order to record data on the optical recording medium and/or reproduce the data recorded on the optical recording medium. The optical pickup comprises an optical element for adjusting the convergence and/or divergence of light emitted from the light source and then proceeded to the objective lens.

According to another aspect of the present invention, there is provided an optical recording and/or reproducing apparatus which records data on an optical recording medium and/or reproduces the data recorded on the optical recording medium using an optical pickup which focuses light emitted from a light source onto an objective lens and irradiates the light on the optical recording medium. The optical pickup includes an optical element for adjusting the convergence and/or divergence of light emitted from the light source and then proceeded to the objective lens.

According to the present invention, it is preferable that the optical element is a hologram optical element that can adjust the convergence and/or divergence of light.

It is preferable that the optical pickup further comprises a collimating lens, and the light emitted from the light source and then passed through the collimating lens and the optical element is converted into parallel light.

It is preferable that the collimating lens has a focal length of 14 mm or less.

It is preferable that the optical pickup has a slim structure.

It is preferable that the optical element is disposed between the light source and the collimating lens.

It is preferable that the optical pickup further comprises a beam shaping device which is disposed between the collimating lens and the objective lens and makes the shape of the light.

It is preferable that the light source includes a plurality of light sources for emitting light beams having different wavelengths and the optical element includes at least optical elements for adjusting the convergence and/or divergence of light beam

emitted from at least one of the plurality of light sources so that the optical pickup is a compatible optical pickup that can be used in a plurality of optical recording media having different formats.

An optical recording and/or reproducing apparatus according to the present invention uses an optical pickup which will be described below according to preferred embodiments the present invention to record data on an optical recording medium and to reproduce the data recorded on the optical recording medium by focusing light emitted from a light source using an objective lens and irradiating the light on the optical recording medium.

FIG. 2 schematically shows the main structure of an optical pickup according to a preferred first embodiment of the present invention;

Referring to FIG. 2, an optical pickup according to the first embodiment of the present invention includes a light source 11, an objective lens 19 for focusing light emitted from the light source 11 and irradiating the light on an optical disc 10, a collimating lens 15 for making the light emitted from the light source 11 into parallel light, and an optical element 13 for adjusting the convergence and/or divergence of light. The optical pickup is used in recording data on the optical disc 10 and/or reproducing the data recorded on the optical disc 10. Reference numeral 17 represents a reflecting mirror.

A semiconductor laser such as an edge emitting laser or a vertical cavity surface emitting laser for emitting light having a predetermined wavelength may be used the light source 11.

In a case where a semiconductor laser is used as the light source 11, the light source 11 emits divergent light.

The collimating lens 15 is disposed between the light source 11 and an optical path changing device or between the optical path changing device and the objective lens 19 so that the collimating lens 15 focuses the divergent light emitted from the light source 11 and makes the light into parallel light.

It is preferable that the collimating lens 15 has a short focal length, for example, a short focal length of 14 mm or less, in order to manufacture an optical pickup into a slim shape.

Since the separate optical element 13 adjusts the convergence and/or divergence of light in the optical pickup according to the present invention, the collimating lens 15 is fixed at a desirable position on a mechanical structure in a process of assembling the optical components included in the optical pickup.

The optical element 13 adjusts the convergence and/or divergence of light so that light which passes through the collimating lens 15 and proceeds to the objective lens 19 is a parallel light or close to a parallel light and has a degree of parallel within a tolerable range. It is preferable that the optical element 13 is disposed between the light source 11 and the collimating lens 15.

A hologram optical element that is configured to adjust the convergence and/or divergence of light may be as the optical element 13. For example, in a case where a hologram optical element having the hologram pattern structure as shown in FIG. 3 is used as the optical element 13, the hologram optical element functions as a lens so that the convergence and/or divergence of light can be adjusted by changing the position of the hologram optical element along the optical axis.

As described above, in the optical pickup having the separate optical element 13 for adjusting the convergence and/or divergence of light, the collimating lens 15 is fixed at the desirable position on the mechanical structure in the process of assembling the optical components, and the convergence and/or divergence of light is adjusted by changing the position of the optical element 13 along the optical axis.

Since the optical pickup according to the present invention adjusts the convergence and/or divergence of light using a hologram optical element as the optical element 13, instead of adjusting the convergence and/or divergence of light using the collimating lens 15 as in the prior art, a process of assembling the optical components of the optical pickup is simpler for the present invention than the prior art.

Since the hologram optical element used as the optical element of the optical pickup according to the present invention can be designed to be greatly insensitive to an optical alignment error compared to a general optical lens, managing parallel light by changing the position of the hologram optical element 13 along the optical axis is easier than adjusting by changing the position of the collimating lens 15 along the optical axis.

The optical pickup according to the first embodiment of the present invention further includes an optical path changing device (not shown) which changes the optical path of light and a light receiving optical system (not shown) which receives light reflected from a recording surface of the optical disc 10.

The optical path changing device and the light receiving optical system are not shown in FIG. 2 for convenience in order to show that the optical pickup has the collimating lens 15 having a short focal length of, for example, 14 mm or less, making the optical pickup suitable for the slim optical recording and/or reproducing apparatus.

An optical path changing device and a light receiving optical system of optical pickups according to second and third embodiments of the present invention can be applied as those of the optical pickup according to the first embodiment of the present invention. Thus, the optical path changing device and the light receiving optical system will not be described and shown in the first embodiment.

Meanwhile, the wavelength of the light emitted from the light source 11, the number of light sources 11, and the numerical aperture of the objective lens 19, etc. may be suitably changed depending on the optical recording and/or reproducing apparatus using the optical pickup.

For example, the optical pickup according to the present invention includes the single light source and the objective lens having the proper numerical aperture so that the optical pickup may be applied to one family of optical disc or a plurality of types of optical discs having different formats. That is, the optical pickup according to the present invention can be configured to a compatible optical pickup that can be applied to a plurality of families of optical discs.

Specifically, referring to FIGS. 4 and 5, an optical pickup according to the present invention includes a single light source 11 which emits light having a wavelength of, for example, 655 nm and an objective lens 19 having a numerical aperture of 0.6 or 0.65 so that the optical pickup can be configured to be applied to DVD family optical discs or compatibly both DVD family optical discs and CD family optical discs.

FIG. 4 shows the optical structure of an optical pickup according to a preferred second embodiment of the present invention. The second embodiment is characterized in that an optical element 13 and a collimating lens 15 are disposed between the light source 11 and an optical path changing device; that is, a plate beam splitter 23 and the optical pickup includes a beam shaping device 21 for making the shape of the light.

The beam shaping device 21 is disposed on the an optical path of light converted into parallel light after passing though the optical element 13 and the collimating lens 15.

As shown in FIG. 4, in a case where the collimating lens 15 and the beam shaping device 21 are disposed between the light source 11 and the plate beam splitter 23, light which has been reflected from an optical disc 10, passed through the plate beam splitter 23, and proceeded to a light receiving optical system becomes parallel light in a beam shaping state.

Thus, it is preferable that a condensing lens 25 for condensing the parallel light and a concave lens 27, a so-called Yo-lens which is used to form a light spot having a proper size on a photodetector 29, are disposed between the plate beam splitter 23 and the photodetector 29.

In FIG. 4, reference numerical 22 represents a grating which splits the light emitted from the light source 11 into at least three light beams to detect a tracking error signal using a three-beam method.

FIG. 5 shows the optical structure of an optical pickup according to a preferred third embodiment of the present invention. The third embodiment is characterized in that an optical element 13 is disposed between a light source 11 and an optical path

changing device; that is, a plate beam splitter 23 and a collimating lens 15 and a beam shaping device 21 are disposed between the plate beam splitter 23 and an objective lens 19. In FIG. 5, the same reference numerals as those in FIGS. 2 and 4 represent the same components, and thus their descriptions will be omitted.

As shown in FIG. 5, in a case where the collimating lens 15 and the beam shaping device 21 are disposed between the plate beam splitter 23 and the objective lens 19, light which has been reflected from an optical disc 10, passed through the plate beam splitter 23, and proceeded to a light receiving optical system becomes convergent light.

Thus, it is preferable that only a concave lens 27, a so-called Yo-lens which is used to form a light spot having a proper size on a photodetector 29, is disposed between the plate beam splitter 23 and the photodetector 29.

In a case where the optical pickup has the optical arrangement as shown in FIG. 5 and uses the plate beam splitter 23 as the optical path changing device, it is preferable that the concave lens 27 is disposed to be inclined in a direction opposite to a direction in which the plate beam splitter 23 is inclined, in order to remove coma aberration generated when the light reflected from the optical disc 10 passes through the plate beam splitter 23.

The optical pickup according to the present invention may include a plurality of light sources which emit light beams having different wavelengths and a plurality of optical elements which adjust the convergence and/or divergence of light beams emitted from the plurality of light sources. Thus, the optical pickup can be configured to a compatible optical pickup that can be applied to a plurality of optical discs having different formats, that is, a plurality of families of optical discs. An optical pickup including the plurality of light sources and the plurality of optical elements is shown in FIG. 6.

FIG. 6 shows the optical structure of an optical pickup according to a preferred fourth embodiment of the present invention. Referring to FIG. 6, the optical pickup according to the fourth embodiment includes first and second light sources 31a and 31b

which emit light beams having different wavelengths, a single photodetector 29, and a single objective lens 19, and the optical pickup can be configured to a compatible optical pickup that can be used in both DVD family optical discs and CD family optical discs. Further, a collimating lens 15 and a beam shaping device 21 are disposed between a first optical path changing device, which will be described below, and the objective lens 19. In FIG. 6, the same reference numerals as those of the above embodiments represent the same components, and thus their descriptions will be omitted.

One of the first and second light sources 31a and 31b emits a light beam having a wavelength of, for example, 655 nm and the other emits a light beam having a wavelength of, for example, 785 nm.

It is preferable that the optical pickup according to the fourth embodiment, as shown on FIG. 6, includes two optical elements 33a and 33b which adjust convergence and/or divergence of light beams emitted from the first and second light sources 31a and 31b.

Since the index of refraction of the collimating lens 15 or the index of refraction of optical components disposed between the first and second light sources 31a and 31b and the collimating lens 15 varies with depending on the wavelength of incident light beam, the lengths of optical paths of the beams having the different wavelengths emitted from the first and second light sources 31a and 31b are different from each other due to the difference in index of refraction of the optical components according to wavelength. As a result, light beams may be converged or diverged. In the optical pickup according to the fourth embodiment including two light sources 31a and 31b and one collimating lens 15 as shown in FIG. 6, the convergence and/or divergence of light beams emitted from the first and second light sources 31a and 31b are preferably adjusted using the optical elements 33a and 33b because it is not proper that the collimating lens 15 is moved.

Although the optical pickup shown in FIG. 6 includes two optical elements 33a and 33b to adjust the convergence and/or divergence of light beams emitted from the

first and second light sources 31a and 31b, the optical pickup may include only one optical element to adjust the convergence and/or divergence of any one of light beams emitted from the first and second light sources 31a and 31b.

For example, the optical pickup according to the present invention includes two light sources and may be applied to compatibly at least any of DVD family optical discs and at least any of CD family optical discs. Further, the optical pickup according to the present invention may be configured such that convergence and/or divergence of light beams for the DVD is not adjusted, and convergence and/or divergence of light beam for the CD is adjusted.

A grating 22 and the optical element 33a are installed separately in FIG. 6. However, the grating 22 and the optical element 33a may be formed in one united body.

The optical pickup according to the fourth embodiment of the present invention includes the first optical path changing device for changing the traveling path of the light beam emitted from the first light source 31a and a second optical path changing device for changing the traveling path of the light beam emitted from the second light source 31b. In FIG. 6, a cubic beam splitter 43 is used as the first optical path changing device, and a plate beam splitter 45 is used as the second optical path changing device.

In a case where the plate beam splitter 45 is used as the second optical path changing device, as in FIG. 6, it is preferable that a concave lens 27 is disposed to be inclined in a direction opposite to a direction in which the plate beam splitter 45 is inclined, in order to remove coma aberration generated when the light reflected from the optical disc 10 passes through the plate beam splitter 45, as in the above embodiments.

The optical pickup according to the second through fourth embodiments of the present invention can include a collimating lens having a short focal length, such as the collimating lens as in the first embodiment.

FIGS. 7 through 9 show first through third examples of the beam shaping device 21 used in the optical pickup according to the second through fourth embodiments, respectively, of the present invention. Examples of the beam shaping device 21 of the optical pickup according to the present invention includes beam shaping devices 51, 53,

and 55 shown in FIGS. 7 through 9. The beam shaping device according to the present invention is not limited to the structure of the beam shaping devices shown in FIGS. 7 through 9 and may have various structures known in the art.

The beam shaping device 53 shown in FIG. 8 functions as a reflecting mirror. Thus, in the optical pickup according to the present invention, the beam shaping device 53 is disposed at the position of the reflecting mirror 17, and the reflecting mirror 17 is removed.

[Effect of the Invention]

As described above, an optical pickup according to the present invention is a finite optical system including a collimating lens and can manage parallel light by adjusting the convergence and/or divergence of light using an optical element. However, the optical pickup according to the present invention is not limited to this. That is, the optical pickup according to the present invention may be a finite optical system including an optical element which adjusts the convergence and/or divergence of light. Further, in the present invention, the optical element which adjusts the convergence and/or divergence of light may be used in generating optical aberration on purpose, if needed.

According to the present invention, since the convergence and/or divergence of light is adjusted using the separate optical element, an assembling process of the optical pickup is simple and it is easy to adjust the convergence and/or divergence of light.

According to the present invention, the present invention can be applied to an optical system which greatly generates optical aberration by the convergence and/or divergence of light, as in a slim optical pickup including a collimating lens having the short focal length or an optical system including an optical component such as a beam shaping device. Further, the present invention can be applied to an optical recording and/or recording apparatus using the above optical pickup which is necessary to manage the optical aberration.

While the present invention has been particularly shown and described with reference to preferred embodiments thereof, it will be understood by those of ordinary skill in the art that various changes in form and details may be made therein without departing from the spirit and scope of the present invention as defined by the appended claims.